

- DAG simulation capabilities at ARC
- Simulation Architecture
- ADRS-The Distributed Simulation Hub
- Some Requirements for ARC-LaRC connection
- Options and Proposal for data connection

# DAG Simulation capabilities at ARC

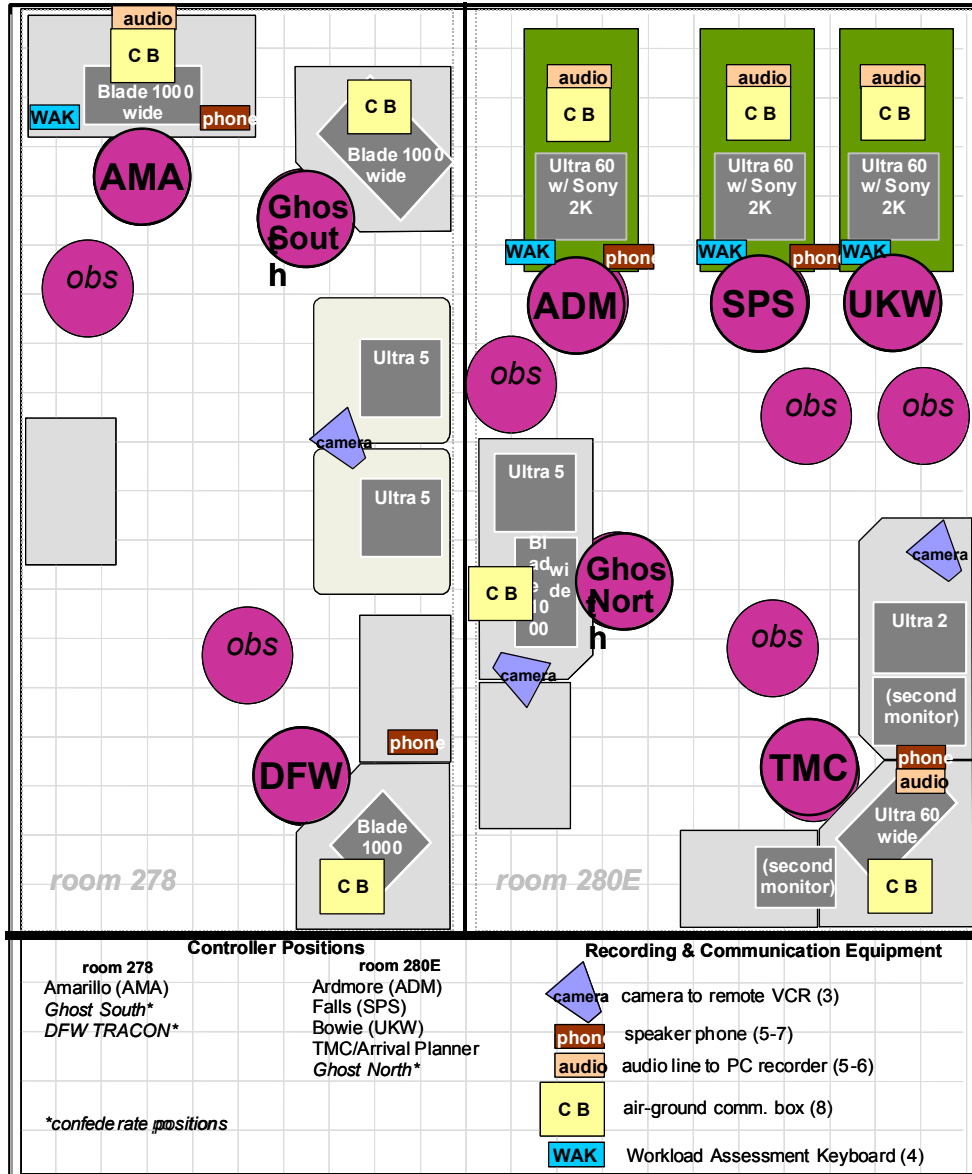
- **AOL**
- ATC,
- multi aircraft pilot stations
- Experiment control
- **CDTI-LAB**
- Fully equipped desktop pilot stations
- **CVSRF**
- Fully equipped full mission flight simulator
- **Remote Sites**
- SJSU
- **Rotorcraft:**
- Fully equipped desktop pilot stations



Controllers in Airspace Operations Lab  
Ames - September 2001 - Photo B. Shelden



# Airspace operations laboratory (AOL)

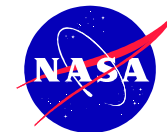


- 6 Center Controller positions
  - 3 full size Radar displays
  - 3 wide screen Radar displays
- 1 Traffic Management position
  - Timeline Gui, Overview, Planning GUI
- 1-3 TRACON controller positions
- Up to 12 pseudo pilot positions on MACS stations

# Decision support tools accessible for Air Traffic Controllers

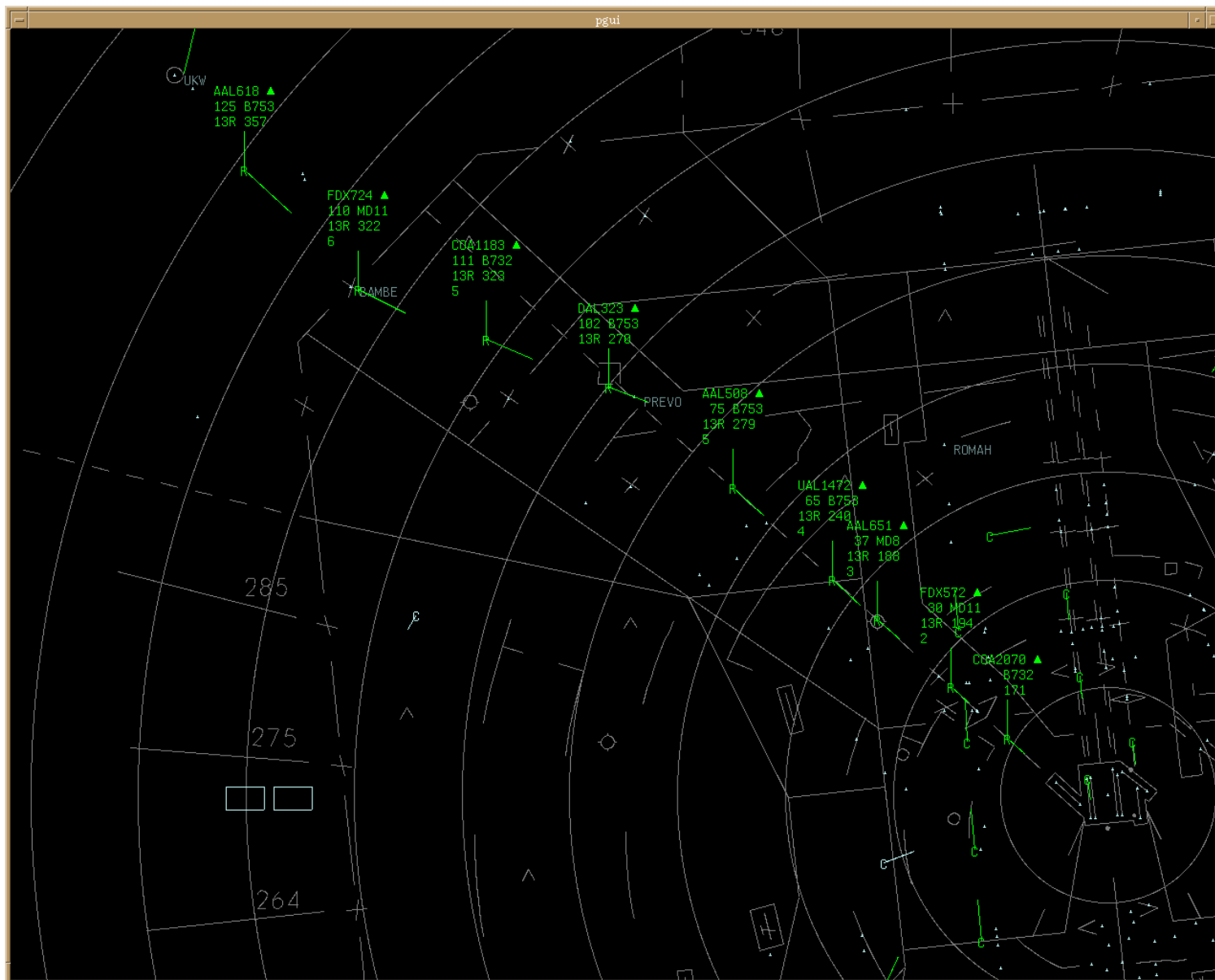
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- CTAS Traffic Management Advisor (TMA)
- Descent Advisor (DA) → EDA
- Final approach spacing tool (FAST)
- Include:
  - Scheduling and sequencing support
  - Conflict probe
  - Trajectory visualization tools
  - Trial Planning and Advisories on controller request
- Self Spacing (CE11) support for TRACON controllers
- Controller Pilot Data Link Communication (CPDLC)
- ADS(B) state and trajectory intent information

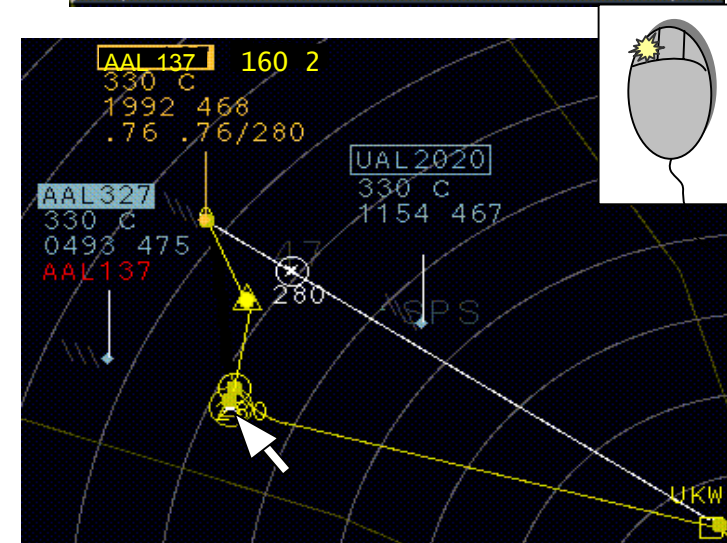
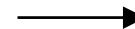


Currently  
CTAS  
Planview  
Graphical  
User  
Interfaces  
(PGUI)

# Controller displays (TRACON)

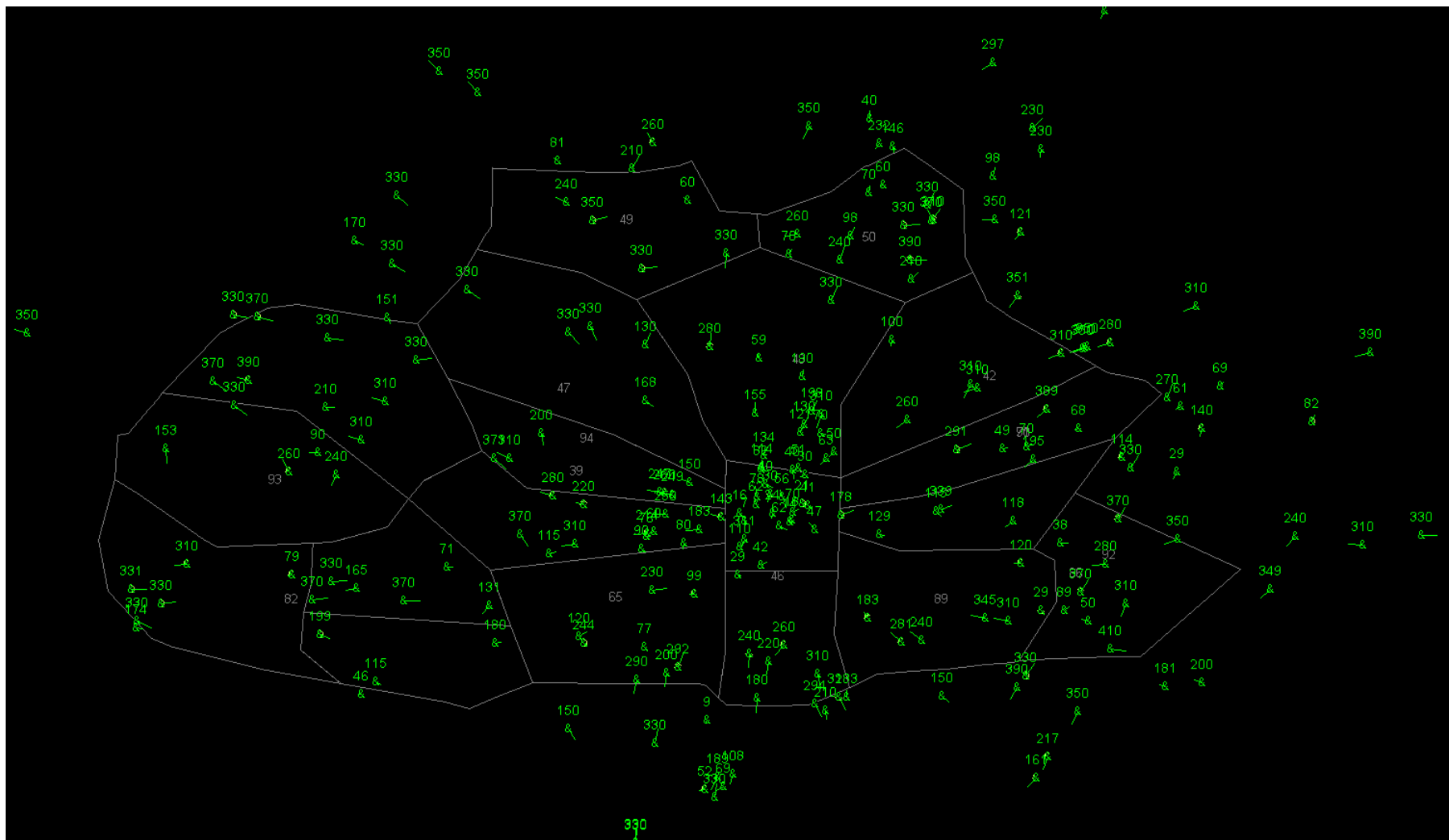


# Trial Planning for Controllers



## Desktop based flight simulators

### Prerecorded traffic      MACS



# Multi Aircraft Control System

## MACS pilot station

MACS-V-0.9.2g USER: guest CONFIG: ama

FILE WINDOWS DISPLAY AIRCRAFT TOOLS HELP

HOME ATC PILOT AOC CUSTOM ADMIN

VIEW 55 AC

TO DO 2 AC

Pilot Handoff SWA 1363

App 118.1 App 118.42 App 119.87 Ctr120.77 Ctr126.3 Ctr127.85 Ctr128.1 Ctr133.25 Ctr135.45 CONTROL

Mode Control Panel SWA 1363

SPEED .70 HEADING 093 ALTITUDE 31785

SPD SEL VNAV SPACING HDG SEL LNAV FLCH VNAV

MACH MACH TOT .70 <LEFT 093 RIGHT> SET ALT >> 31000

FMS VNAV Panel SWA 1363

CRZ ALT >> 31000

CLB SPD CRZ SPD DES SPD

0 .70 280

FMS Route Panel SWA 1363

NEXT WAYPOINT >> GANJA

DEPARTURE >> GRGF1

STAR >> 13L

TRANS >> 13L

APPROACH >> 13L

PFD SWA 1363

CRUISE

31000

31860

31500

1986

ATC CTRL

MAP SWA 1363

NAV ARPT RT WPT WXR TRFC IDS

GS 444 TAS 409 TRK 093 MAG 01:25:58 5.1

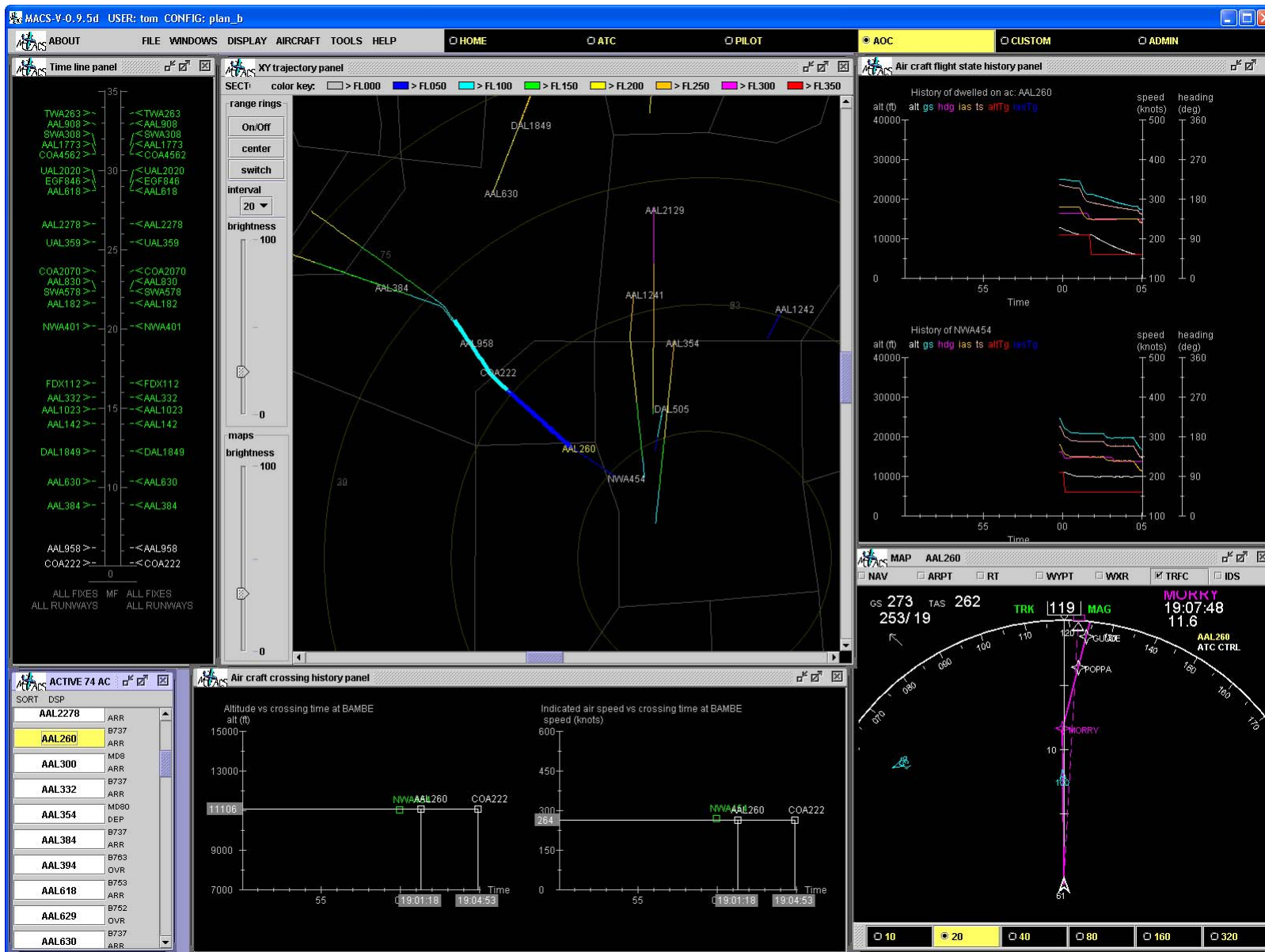
SWA1363 ATC CTRL

ZANTO 31000/246 01:31:43

GANJA 31000/246 01:25:58

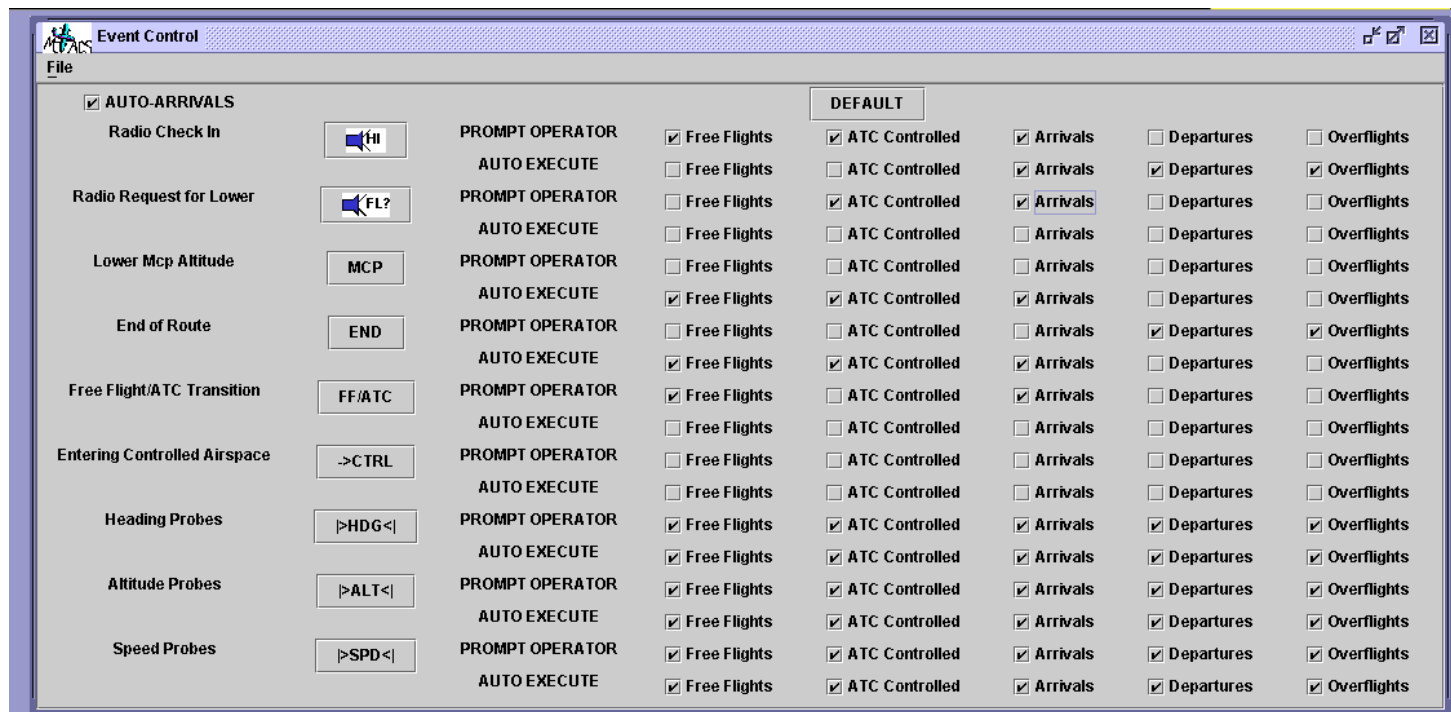
10 20 40 80 160 320

# MACS Analysis View



# Automated Agents

- CATS can act as model-based agent for certain aspects of the simulation
- MACS can be configured for automatically performing tasks or prompting operators



# Experiment control and management

MACS-V-0.9.2g USER: guest CONFIG: ama

ABOUT FILE WINDOWS DISPLAY AIRCRAFT TOOLS HELP
HOME ATC PILOT AOC CUSTOM ADMIN

Thread Control

Name	Alive	Run	Const	Cycle setting	Last	Mean
acManagerThread:Thread-4	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1000	1010	1007
processManagerThread:Thread-5	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1000	1010	1007
displayManagerThread:Thread-1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1000	1012	964
dcThread:Thread-31	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	10000	10010	9986
mainWinThread:Thread-32	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	500	510	515
msgHandlerThread:Thread-33	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	3000	3010	2143
autoControllerThread:Thread-34	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1000	1010	1010
guidanceControllerThread:Thread-35	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	2000	2010	2008
threadObserverThread:Thread-36	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1000	1010	1010
threadControllerThread:Thread-7: Thread Control	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1000	1047	990
winUpdaterThread:Thread-8: PROCESS VIEW	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1000	1145	997
winUpdaterThread:Thread-9: Event Control	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1000	1010	990
listWinUpdaterThread:Thread-10: ALL	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	10000	0	505
listWinUpdaterThread:Thread-11: ACTIVE	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	10000	0	615
listWinUpdaterThread:Thread-12: INACTIVE	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	10000	0	538
listWinUpdaterThread:Thread-13: CTRL	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	10000	0	594
listWinUpdaterThread:Thread-14: VIEW	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	10000	0	630
listWinUpdaterThread:Thread-15: TO DO	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	10000	0	628
listWinUpdaterThread:Thread-16: DONE	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	10000	0	569
winUpdaterThread:Thread-17: GENERIC ATC VIEW	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1000	1010	827
winUpdaterThread:Thread-18: STARS VIEW	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1000	1010	969
acWinUpdaterThread:Thread-19: Mode Control Panel	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1000	1010	974
acWinUpdaterThread:Thread-20: MCP (757 Style)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1000	1010	965
acWinUpdaterThread:Thread-21: MAP	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1000	1010	965
acWinUpdaterThread:Thread-22: PFD	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1000	1010	963
acWinUpdaterThread:Thread-23: AC-STATE	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1000	1010	966
acWinUpdaterThread:Thread-24: FMS VNAV Panel	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1000	1010	976
acWinUpdaterThread:Thread-25: FMS Route Panel	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1000	1010	965
acWinUpdaterThread:Thread-26: Self Spacing Panel	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1000	1000	963
acWinUpdaterThread:Thread-27: Pilot Handoff	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1000	1010	978
winUpdaterThread:Thread-28: Probe Control Panel	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1000	1010	996
winUpdaterThread:Thread-29: Data tag configuration setup Panel	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1000	1000	993
winUpdaterThread:Thread-30: Time line panel	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1000	1010	996
msgParserThread:Thread-37	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	30	36	11
msgSenderThread:Thread-38	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	500	510	423

PROCESS VIEW

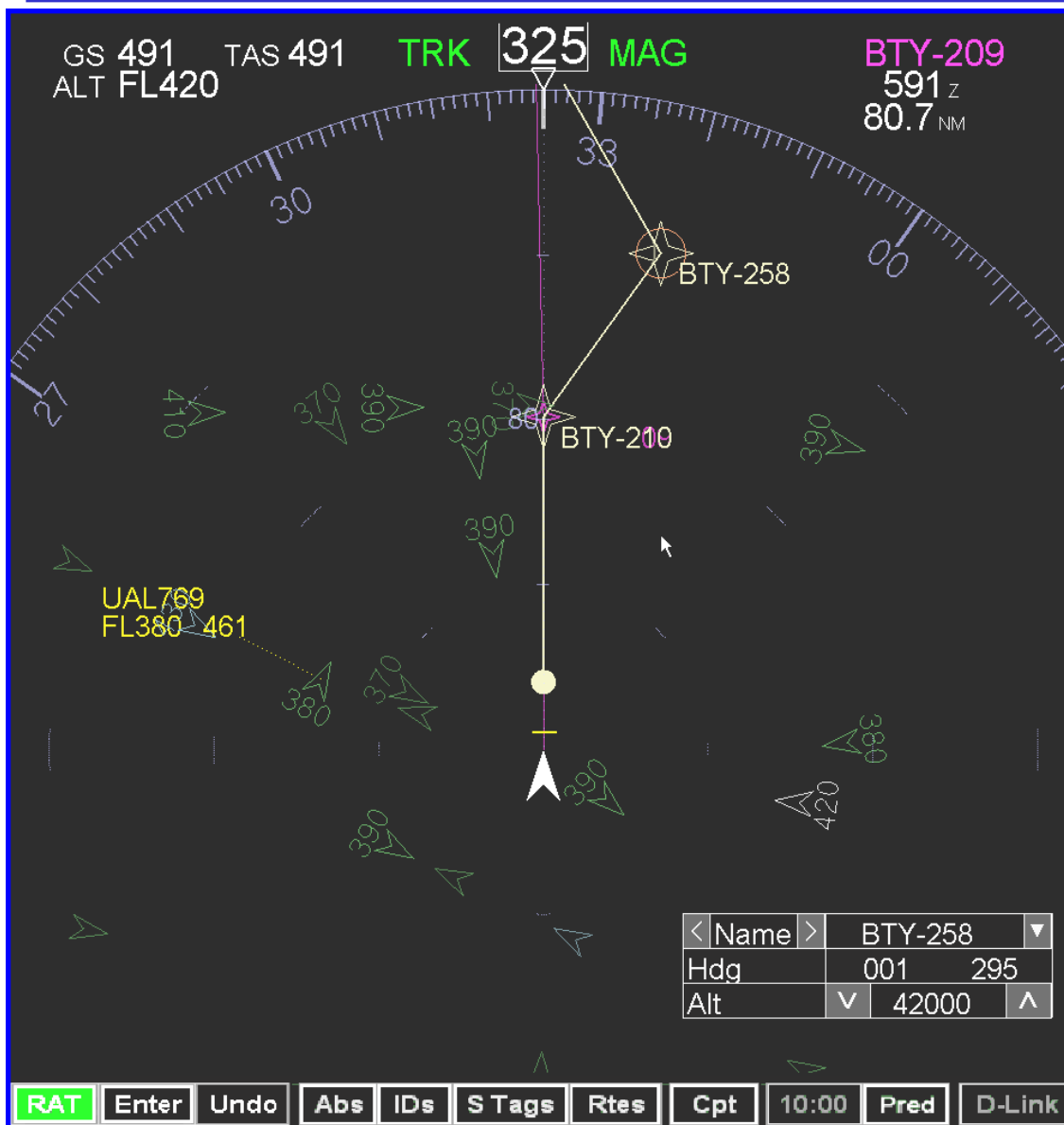
ADRS ON cedex CONNECTED AT 18:00:34

STATUS NOW RECEIVED REPORTED DELAY MINIMUM DRIFT OF-LEVEL

19:06:26	19:06:26	19:06:27	1.399	1.506	0.107	0	19:06:26
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ADRS-ON	TALKS VIA	TO	ON	5s Avg In	5s Avg Out	30s Avg In	30s Avg Out	RECEIVED	
				Mgs	Byts	Mgs	Byts	ToGo	
cedex.arc.nasa.gov	MPI	JAVA PILOT STATION	oakey.arc.nasa.gov:2	0	0	46	15254	0	19:06:26
cedex.arc.nasa.gov	MPI	ADRS (SERVER)	gates	45	14886	2	1227	0	19:06:25
gates.arc.nasa.gov	MPI	ADRS (SERVER)	pueblo	44	14514	0	1976	0	19:06:25
gates.arc.nasa.gov	CENTER ISM	CTAS	heaftr.arc.nasa.gov	0	0	43	10335	0	19:06:25
gates.arc.nasa.gov	CENTER ISM	CTAS	conny.arc.nasa.gov	0	0	43	10335	0	19:06:25
pueblo.arc.nasa.gov	COMMON IF	PAS	pueblo	44	10706	0	54	0	19:06:25
pueblo.arc.nasa.gov	ADS-B	PAS	pueblo	1	6312	0	0	0	19:06:25
cedex.arc.nasa.gov	MPI	JAVA PILOT STATION	stins.arc.nasa.gov:3	1	476	46	15148	0	19:06:25
pueblo.arc.nasa.gov	MPI	ADRS (CLIENT)	gates.arc.nasa.gov:3	3	1970	44	14514	0	19:06:25
gates.arc.nasa.gov	MPI	ADRS (CLIENT)	cedex.arc.nasa.gov:3	2	1227	46	14886	0	19:06:25

# Cockpit Display of Traffic Information

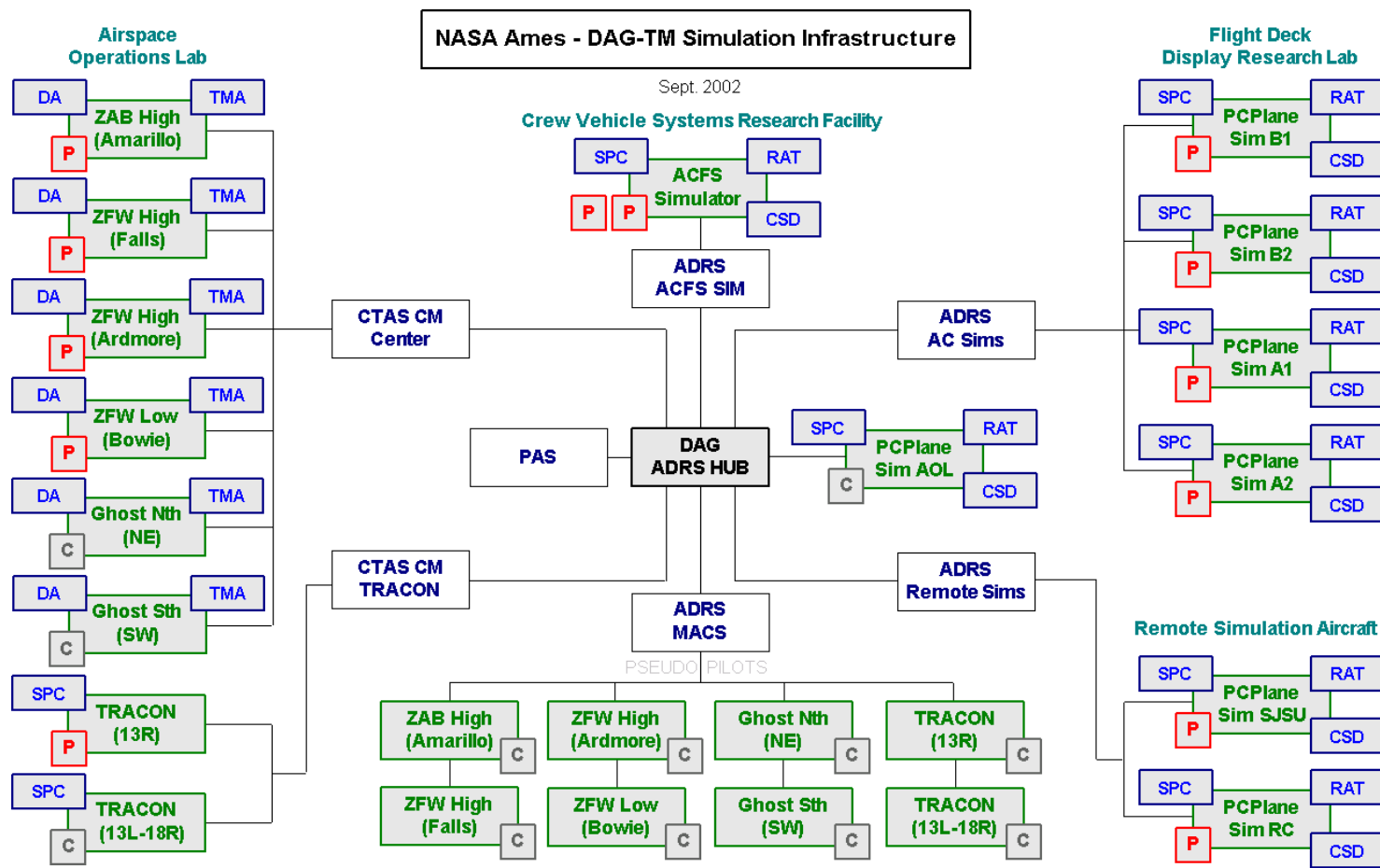


# Desktop based single pilot station



Integrates NASA Langley's PC-Plane with the CDTI and data link

# Simulation Architecture



**ACFS** Advanced Concepts Flight Simulator

**ADRS** Aeronautical Datalink and Radar Simulator

**CM** Communications Manager

**CSD** Cockpit Situation Display

**CTAS** Center TRACON Automation System

**DA** Descent Advisor (CTAS)

**FAST** Final Approach Spacing Tool (CTAS)

**MACS** Multi Aircraft Control System

**PAS** Pseudo Aircraft System (traffic generator)

**TMA** Traffic Management Advisor (CTAS)

**RAT** Route Assessment Tool (CSD)

**SPC** Spacing Capability (CSD)

**P** Participant

**C** Cohort Position

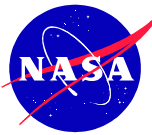
**ZFW High (Ardmore)** Operator Station

**ADRS** Processor

**SPC** Decision Support Tool

- *\*Aeronautical Datalink and RADAR Simulator*
- Distribution of communication load:
  - Unlimited number of servers and clients can be connected by adding identical ADRS processes to the simulation network that share their information
- Merging of multiple homogeneous aircraft data sources into one scenario
- Host emulation
- Radar simulation
- Datalink simulation
- Aircraft state and trajectory data harmonization and maintenance
- Process control and monitoring

# Requirements for Ames-Larc Data Connection



- Minimum/no changes to simulation end-processes
  - ASTOR, CDTI, CDTI-PcPlane, CTAS, MACS, ACFS
- Aggressive Timeline
  - Full Experiment in FY04:
  - September 03: Demo with full capabilities
  - May/June 03: Connectivity Event
  - March 03: Initial Lab connection
- All existing and defined DAG capabilities should be supported
  - Information exchange for
    - Flight Plan information
    - Complete aircraft state information @ 1 second
    - Trajectory intent broadcast whenever it changes and at waypoints/intervals
    - Route\*, speed\* and RTA uplinks
    - Trajectory request downlinks \*
    - Weather (RUC, NexRad, FIS-B) synchronization
- Long term perspective
  - Support future projects (e.g. VAMS)

\* CE6 only

# Possible Connections ARC to LaRC

Type	status	Communication	Changes to processes	Resource requirements	Information exchange requirements	Risk Not to be ready
ADRS To individual PcPlanes	Completed in 1999 Frequently In use	ADRS-LARC ICD and ARINC702+ Or PasCommon	None at Ames, ASTOR may be incompatible. PcPlane exists	Low	supported	Low
ADRS To ASTOR with custom ICD	Started in 2000, ADRS with basic hooks delivered, ASTORs connected ?	ADRS-ASTOR ICD and ARINC702+	LaRC ADRS changes need to be merged back to Ames baseline. LaRC ?	Low to moderate	supported	moderate
<b>ADRS To ATOS with HLA/A702P</b>	<b>HLA supported at LaRC, not yet at ARC. A702p message handling available</b>	<b>HLA and ARINC702+</b>	<b>ADRS changes for HLA. ATOS need to distribute/collect information to/from ASTORS</b>	<b>moderate</b>	<b>supported</b>	<b>Moderate</b>
ADRS To ATOS Hub with pure HLA	Not started	HLA	Needs to be built into ADRS from scratch. May exist at Langley	high	Probably supported	high

# ADRS-ATOS HLA/ARINC702P connection

Long Range ARC-LaRC communication handled by ADRS to ADRS TCP/IP via internet. (Supports all messages, reliable, frequently used, fast enough)

ADRS to ATOS high level communication handled by HLA wrapper

Aircraft dependent messages exchanged via ARINC 702P datalink specification, new messages communicated as free text

Filed flight plans can be communicated by dedicated message or stored locally in Scenario Data Base

Wind files pre-loaded, no on-line update

Weather Hazard synchronization TBD

Allows LaRC to run additional MACS stations for air traffic monitoring (or participation as unmanaged aircraft).

